FOREST LAKE

BASELINE SURVEY AND MANAGEMENT RECOMMENDATIONS

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INTRODUCTION

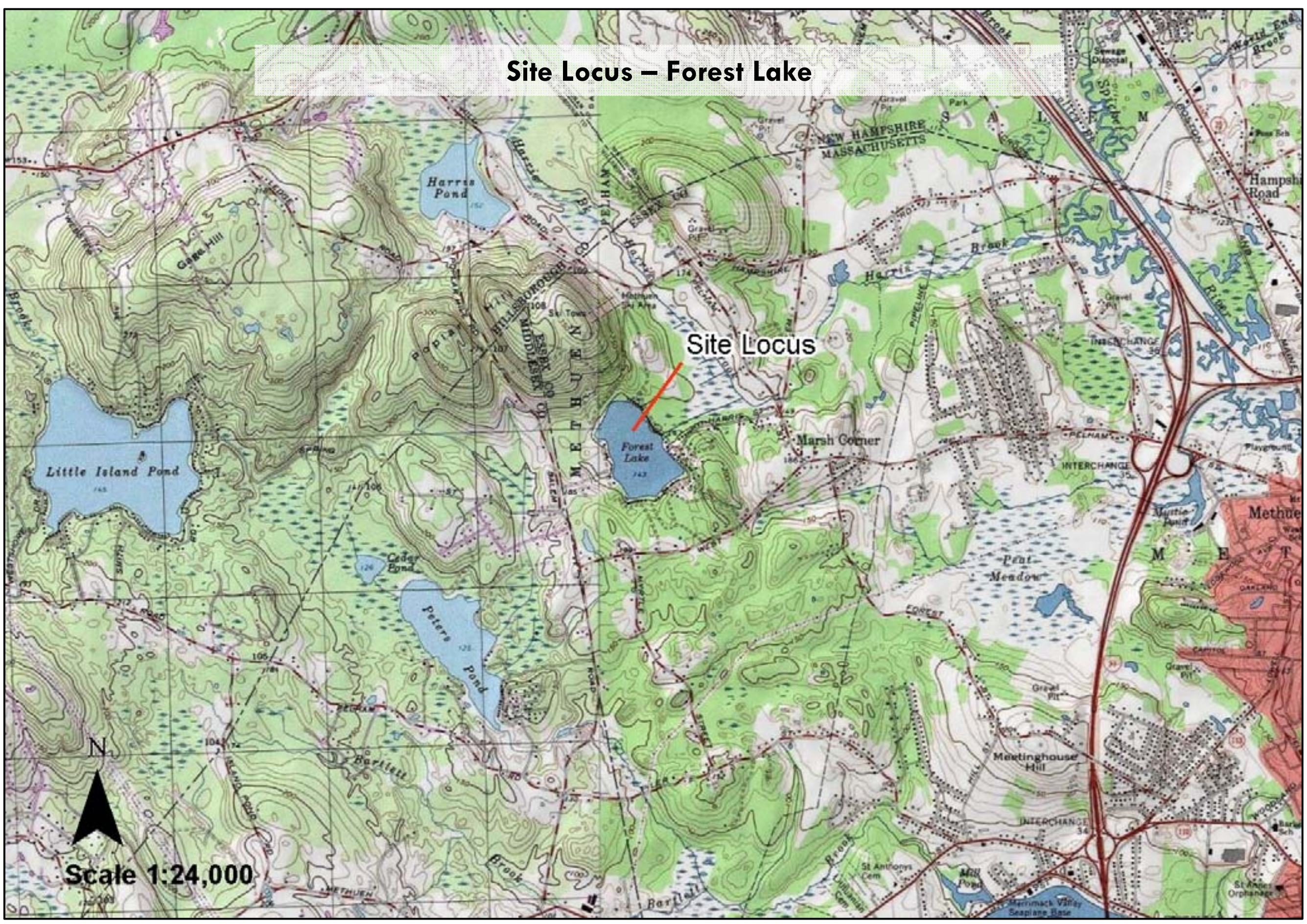
In the fall of 2012 Aquatic Control Technology, Inc. (ACT) was contracted by City of Methuen to conduct a baseline biological survey of Forest Lake.

Field survey work was performed on September 10, 2012. A point intercept methodology was used to allow for future replication and quantitative comparison.

The primary goals of the survey work performed in 2012 were to:

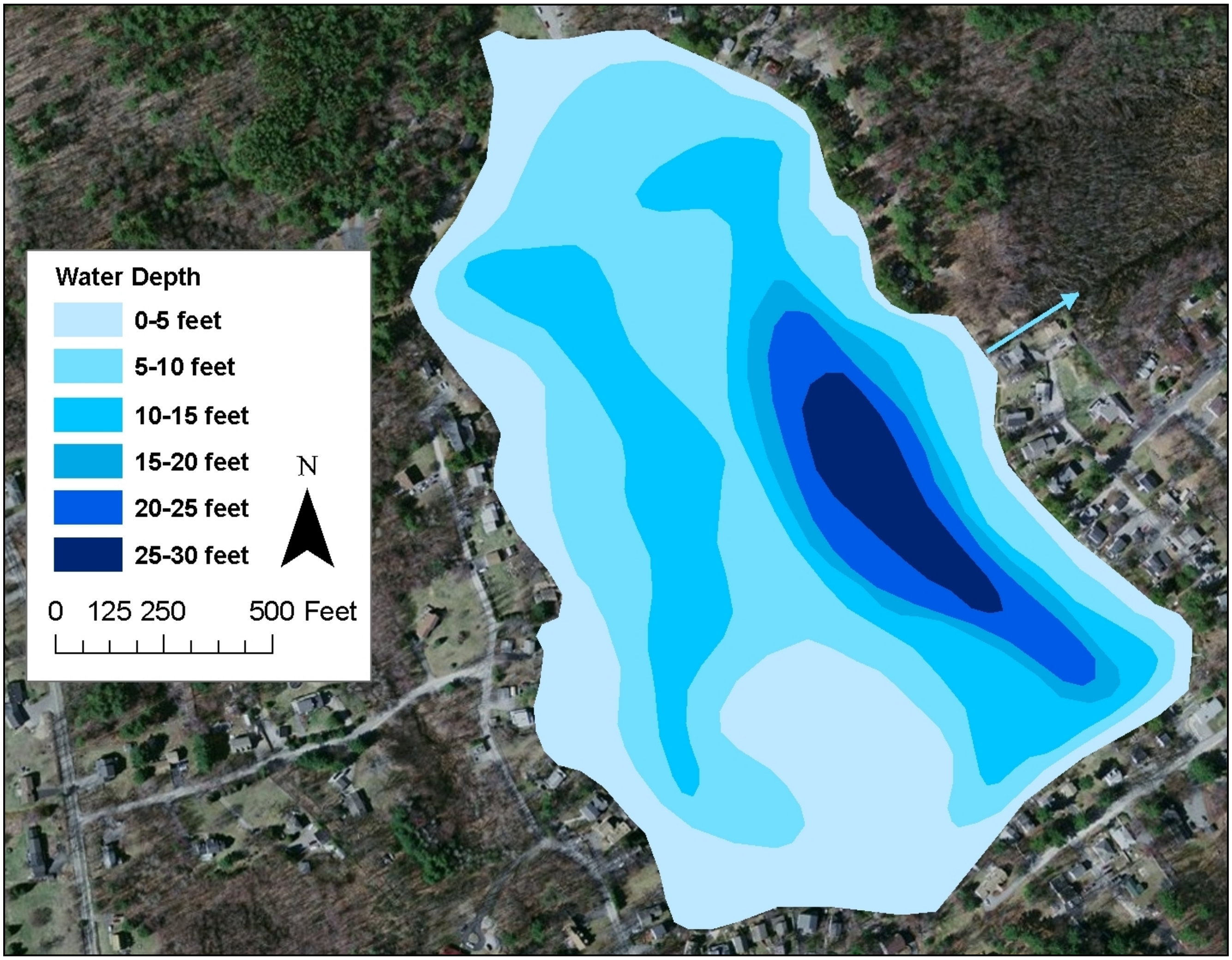
- Establish baseline aquatic plant data for the lake
- Collect and analyze baseline water quality information
- Confirm morphological data
- Provide site specific lake management recommendations

The balance of this report will serve to document the results of our survey and water quality analysis. Management recommendations have been developed based on information collected during the field survey work and discussions with interested parties with the City of Methuen and the Forest Lake Association.



Site Description

Forest Lake is located north of the intersection between Dracut Street and West Street in Methuen, MA. The lake is approximately 50 acres in size with a reported average and maximum water depths of 10 and 28 feet, respectively. The lake has a total estimated capacity of roughly 163 million gallons.



Forest Lake is a *great pond*[1] as classified by the State of Massachusetts which has been enhanced by the construction of a dam located on the eastern shore. The lake has a relatively small watershed reported at roughly 240 acres[2], consisting primarily of single family homes, secondary roads, and wooded areas. The immediate shoreline of the lake is heavily developed with single family homes around most of the shoreline.

Water enters the lake though a combination of groundwater infiltration, overland flow and surface water runoff. Outflow is controlled by a dam with low level outflow control; which draws water from below the lake's surface. Outflow from the lake exits along the eastern shoreline via Harris Brook joining the Spicket River approximately 3 miles downstream.

[1] A great pond is defined as any pond or lake that contained more than 10 acres in its natural state.

[2] Lycott Environmental Research, Inc. *Forest Lake Methuen, Final Draft Report*: 1989. Print.

BASELINE SURVEY

The methodology for the survey used at Forest Lake was derived from the Point Intercept Sampling Method developed by the U.S. Army Corps of Engineers (Madsen 1999). The point intercept method is intended to document the spatial distribution, percent cover and biomass of aquatic plant (macrophyte) species at specific re-locatable data point sites.

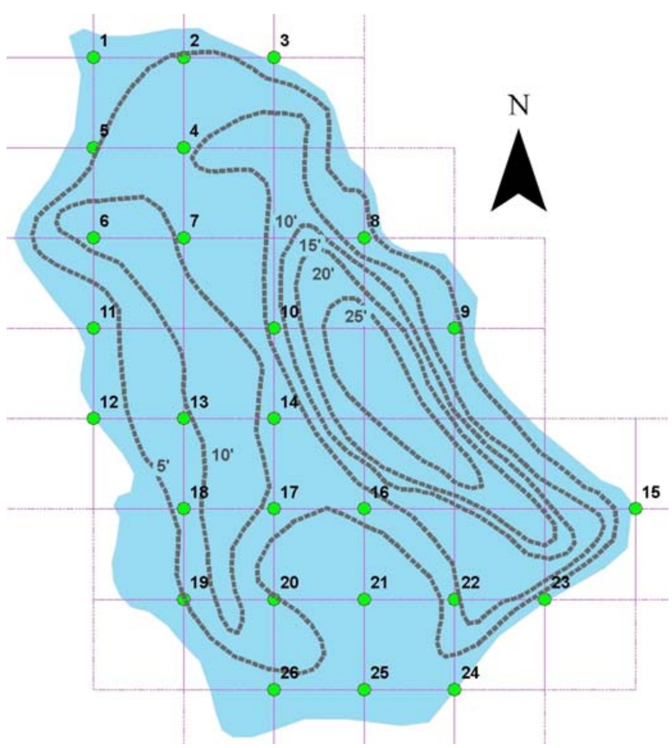
Using ArcView 9.1 software, point intercept data points were created at the vertices of an individually tailored sample grid. The grid was created prior to the field work and was sized according to waterbody area and the anticipated frequency of data points needed to establish a "reasonable" data collection set (see picture below). Areas with a water depth of greater than 15 feet were excluded from the survey because they were beyond the photic zone (area where plants can survive). The grid produced for Forest Lake was 80 meters in size yielding a data point frequency of approximately 0.8 data points per *surveyed* acre (32 acres total).

Data points were navigated to by boat using a Garmin 76Cx GPS unit. At each data point, vegetation was identified and quantified using a combination of a vegetation "throw rake", an underwater AquaVu camera system and visual inspection. Coverage of vegetation was estimated and assigned values based on vegetation density and biomass; dominant aquatic species were also identified at each data point.

Density Index values of 0-4 were assigned based on the following criteria: 0 – No plants, 1 – plant cover between 1%-25%, 2 – plants cover between 26%-50%, 3 – plant cover between 51%-75%, plant cover greater than >75%.

The Biomass Index is representative of the overall height of plants in the vicinity of the sample point. The index ranges from 0-4 according to the following breakdown: 0 – No plants, 1 – plants generally low-growing within a foot of the bottom, 2 – plants generally half-way through the water column, 3 – plants within 1-2 feet of the surface, 4 – plants just below or at the surface.

Data Point Locations:



Basic water quality parameters including Secchi disk water clarity and temperature dissolved oxygen profiles were collected at the deep hole location. Surface water samples were collected from two locations; a third sample was collected near to lake bottom in the deep hole location. Collected samples were packed on ice and were delivered to MicroBac Laboratories in Worcester for analysis.

Tabular field data collected during the survey is attached to the end of this report.

Existing Conditions

Summary of Survey Results	
Surface Area (acres)	50.0
Average Depth (feet)	10
Maximum Recorded Depth (feet)	28
Ave. Plant Density Index	1.4
Ave. Plant Biomass	1.4
Estimated Volume	500 ac-ft. (163 million gal.)
Recorded Plant Species	Richardson's pondweed Thinleaf pondweed, Common waterweed Slender spikerush Tapegrass, Robbins pondweed Whilte waterllily

Overall plant cover in Forest Lake is fairly low with average plant density and plant cover indices averaging just 1.4. Plant diversity was also low with only 7 vascular plants identified sand average species richness of only 1.3 species per data point.

The existing vegetation composition was dominated by Richardson's Pondweed (*Potamogeton richarsonii*) which was encountered at 40% of the surveyed data point locations. Growth of Richardson's Pondweed was tall in most locations were found and was generally at, or within one foot of, the surface (biomass 3-4). Richardson's Pondweed was the dominant species at 8 of the 11 data point locations where recorded, indicating dense growth where found, and could be observed in large beds of in the middle portion of the waterbody.

Thinleaf pondweed (*Potamogeton pusillus)* and common waterweed (*Elodea canadensis*) were also well distributed and were found at approximately 27% and 15% and of the data point locations, respectively. Other aquatic plants identified during the survey included: Robbins pondweed (*Potamogeton robbinsii*), tapegrass (*Vallisneria americana*), white waterlily (*Nymphaea odorata*), Slender spikerush (*Eleocharis tenuis*) and filamentous algae (*Chlorophyta sp.*). Bushy pondweed (*Najas flexilis*) and yellow waterlilies (*Nuphar varigatum*) were also observed, but were not documented at any of the data point locations. With the exception of the floating-leafed waterlily species most of the plant species encountered were low growing with typical biomass indices between 1-2. <u>No invasive or non-native aquatic plants were identified in Forest Lake</u>. A map of the estimated vegetation cover can be found a the end of this report.

The substrate of Forest Lake was predominately a mixture of sand and rock with areas of muck.

Water clarity at the time of the survey was good with a Secchi Disk clarity reading of 12.2 feet. Dissolved oxygen was low averaging 4.54 mg/L at 14.8°C (55% saturation). Dissolved oxygen concentrations above the thermocline (~6.5m) were good averaging 8.78 mg/L at 24.1°C or roughly 100% saturation. Below the thermocline conditions were nearly anoxic with less than 20% saturation averaging 1.05 mg/L at 16.5°C. Low oxygen levels are expected below the thermocline in late summer as a result of poor mixing during summer stratification.

A water sample collected at the "deep hole" on September 10 exhibited low algae densities dominated by blue-green (Cyanophytes) and green (Chlorphytes) alage species which

Temperature/Dissolved Oxygen Profile (9/10/12)		
Depth (m)	**Temp (C°)**	**Dissolved Oxygen (mg/L)**
Surface	24.2	9.07
1	24.2	8.87
2	24.2	8.72
3	24.2	8.76
4	24.2	8.80
5	23.9	8.63
6	23.9	8.62
7	17.6	1.35
8	15.1	0.75

accounted for 47% and 47% of the algae cell density, respectively. Predominant green species included: *Dictyosphaerium*, *Micractinium* and *Chlorella*. The only blue-green species present was *Aphanocapsa*. Overall cell density was very low, estimated at roughly 19,000 cells/ml; generally counts of greater than 75,000 cells/ml are indicative of bloom conditions.

Summary of Water Quality Sampling Results

Water quality samples were collected from Forest Lake on September 10. The samples were packed on ice and delivered to MicroBac Laboratory in Worcester, MA. The samples were analyzed for a suite of basic water quality parameters. Below you will find a summary of the water sample collection results with a brief discussion of the specific parameters and how they relate the lake. When looking at the results it is important to remember that these results indicate a mere snap-shot in time and are not necessarily representative of overall conditions in the lake or watershed.

Summary of Results				
Parameter	**Unit**	**Deep Hole (Surface)**	**Deep Hole (7m)**	**Outlet (Surface)**
pH	S.U.	7.25	6.33	7.31
Alkalinity	CaCO3/L	21.0	31.0	23.0
Turbidity	NTU	0.600	3.10	0.630
Total Kjeldal Nitrogen	mg/L	0.200	0.900	0.500
Ammonia Nitrogen	mg/L	<0.100	<0.100	<0.100
Nitrate	mg/L	<0.100	<0.100	<0.100
Total Phosphorus	mg/L	<0.0100	0.0700	<0.0100
True Color	Pt-Co	5	ND	5
Apparent Color	Pt-Co	10	10	10
E.coli	CFU/100ml	<10	>2000	<10

pH - is a measurement scale used to designate the degree of acid or alkaline condition of a solution. The scale ranges from 0, being the most acidic, to 14, being the most basic or alkaline. The pH value of 7 is considered to be neutral. A pH range of 5.5-8.5 is necessary to maintain a healthy fishery. The pH values obtained at Forest Lake (7.25, 7.31 & 6.33) were well within the acceptable range.

Total Alkalinity – Alkalinity is the measure of the buffering capacity of water against acid additions. Water with high alkalinity, "hard-water" has a higher buffering capacity and is less susceptible to pH fluctuations from changing environmental conditions (i.e. acid rain, entering pollutants). Waterbodies with lower alkalinities (<50 CaCO3/L), or "soft-water" have less capacity to buffer against similar additions. Soft-water is typical in most of eastern Massachusetts so generally values less than 20 CaCO3/L are considered insufficient to protect against adverse pH changes. The average value of 25 mg CaCO3/L shows that the lake is moderately protected from pH fluctuations.

Turbidity – is a gauge of the amount of suspended solids and light refractory materials that are present in the water column, typically suspended algae and/or non-living particulates such as suspended silt/clay. The measurement scale ranges from less than 10 to into the hundreds of units. The turbidity values obtained from Forest Lake averaged 1.64 NTU, indicating low levels of suspended material in the water. Turbidity in the 7m sample (3.1 NTU) was considerably higher than the surface samples which is typically in a stratified system like Forest Lake and is indicative of the isolated conditions of the bottom waters (hypolimnion) in the lake.

Total Kjeldal Nitrogen (TKN) - is a measure of the nitrogen contained in organic compounds, such as proteins and amino acids, as ammonia. It is created from biological growth and decomposition. A concentration of 1.0 mg/L or below is generally considered desirable for freshwater lakes. TKN values reported for Forest Lake were below the aforementioned threshold, however, elevated TKN levels were reported in the 7m sample. Elevated levels of TKN are anticipated in the hypoliminion and are the result of decomposition of organic material on the lake bottom.

Ammonia Nitrogen – is an inorganic, dissolved form of nitrogen that can be found in water. Depending on temperature and pH (a measurement of "acidity"), high levels of ammonia can be toxic to aquatic life. High ammonia concentrations can stimulate excessive aquatic production and indicate pollution. Important sources of ammonia to waterbodies include: fertilizers, human and animal wastes, and by-products from industrial manufacturing processes. In general, acceptable ammonia concentrations should range between 0 and 0.5 mg/L depending upon temperature and pH. Generally values above 0.5 are considered problematic and potentially toxic to fish. The average ammonia nitrogen levels in the lake were all below laboratory detection limits, indicating very low levels of Ammonia nitrogen.

Nitrate - is usually the most prevalent form of nitrogen in water because it is the end product of the aerobic decomposition of organic nitrogen. Nitrate from natural sources is attributed to the oxidation of atmospheric nitrogen by bacteria and the decomposition of organic material in the soil. Nitrate concentrations may range from a few tenths to several hundred parts per million (mg/L). Generally, values greater than 0.3 mg/L are considered capable of supporting excessive vegetation and algae growth. The values obtained from Forest Lake were all below the laboratory detection limit (0.400 mg/L) and are not cause for concern.

Total Phosphorus – Phosphorus is considered the limiting nutrient essential to plant and algae growth. Typically a value of 0.03 mg/L or greater is sufficient to stimulate excessive plant and algae growth. The only detectable phosphorus "hit" was found in the 7m sample. While phosphorus was fairly elevated in this sample, results like this are expected in late summer and are the result of poor mixing and oxygen depletion during summer stratification.

Phosphorus can enter an aquatic system in different ways; for example, phosphorus can be introduced into the waterbody from the watershed (the land area surrounding the lake that funnels rainwater to the lake) either from a specific source or from non-point origins. Sources of phosphorus include lawn fertilizers, storm water runoff, septic/animal wastes and other sources. In addition to external phosphorus inputs phosphorus can be recycled internally from decaying vegetative biomass. Phosphorus load calculations from 1988 indicate that a significant portion of the phosphorus load was due to internal recycling, however improvements to the watershed, including the sewering of all shoreline houses has been performed since that testing was completed[3]. More comprehensive testing would need to be performed to better understand current phosphorus loading

True and Apparent Color - Apparent color is the color of the raw water sample, and consists of color due to both dissolved and suspended components. True color is measured by filtering the water sample to remove all suspended material, and measuring the color of the filtered water, which represents color due to dissolved components.

To measure true color, the color of the filtered water sample is matched to one from a spectrum of standard colors. Each of the standard colors has been assigned a number on a scale of platinum-cobalt units (abbreviated as Pt-Co units). On the PCU scale, a higher value of true color represents water that is darker in color. (Lake water generally ranges between 0-500 Pt.-Co.)

Dissolved organic materials such as humic acids from decaying leaves, and dissolved minerals can give water a reddish brown "tea" color. The presence of color can reduce both the quantity and quality of light penetrating into the water column. Changing the quantity and quality of light reaching the bottom of a waterbody can influence the depth of colonization and the types of aquatic plants and algae that can grow there. In some waterbodies, color is the limiting environmental factor. For example, high color concentrations (greater than 50 PCU) may limit both the quantity and types of algae growing in a waterbody. Waterbodies that adjoin poorly drained areas (such as swamps) often have darker water, especially after a rainfall. Consequently, the location of a waterbody has a strong influence on its color. Color indexes in excess of 30 Pt-Co can cause significant reductions in water clarity. The 5 & 10 Pt-Co. values reported at Forest Lake here indicate low amounts of colored dissolved and suspended material in the water column.

***E. coli* Bacteria –** *E. coli* is one of many naturally occurring bacteria found within the intestine of healthy humans and animals. The presence of *E. coli* in lake and/or lake water is indicative of recent sewage or animal waste contamination. The Massachusetts Department of Public Health has standards for the presence of *E. coli* in "swimmable waters". The current standard for freshwater is no single sample shall exceed 235 colonies per 100 ml. Results from both surface water samples collected at Forest Lake were below detectable limits (10 per 100 ml), indicating little or no fecal contamination in the surface water. High e. coli counts reported in the 7m sample indicate a fair amount of bacteria "trapped" in the bottom waters of the lake. Similar to the high TKN and phosphorous values reported for this sample, these results are fairly typical and are not cause for any immediate concern. .

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[3] Lycott Environmental Research, Inc. *Forest Lake Methuen, Final Draft Report*: 1989. Print.

EVALUATION OF MANAGEMENT OPTIONS

The following section discusses several aquatic plant management options. Each strategy is evaluated in reference to the current conditions at Forest Lake, discussing both advantages and disadvantages of the particular technique.

Hand-Pulling, Suction Harvesting and Benthic Barriers

Hand-pulling, suction harvesting (or DASH - diver assisted suction harvesting) and benthic barrier installations are generally used to control small localized patches of dense plant growth or widely scattered aquatic plant growth. The efficiency and high per-acre unit cost of these control strategies often limits their application to newly discovered, "pioneer" infestations of non-native vegetation; follow-up to a larger scale management strategies; and for localized control of nuisance plant growth in high use/swim areas. Given the density, distribution and composition of aquatic vegetation in Forest Lake the use of hand-pulling and/or installation of benthic barriers for control of nuisance vegetation in high-use/swim-areas is recommended

Benthic barriers (a.k.a. bottom weed barriers) are commonly used to suppress weed growth in situations where chemical treatment is not allowed or effective. Benthic barriers are typically composed of a PVC coated fiberglass that is arranged in a mesh/net layout. The mesh/net layout allows for natural bacterial decomposition of bottom sediments and the escape or related gases. The barrier is typically weighted down to prevent it from shifting its location. Rocks, bricks and capped PVC tubes filled with concrete rebar are common items used to anchor the barrier. Bottom weed barriers need to be retrieved, cleaned and re-deployed annually or biennially (every other year) to prevent sediment from collecting on the surface of the barrier. The use of a benthic barriers in high use/individual swim areas should provide adequate control of nuisance plant growth in a targeted areas, with minimal annual maintenance.

Alternatively, SCUBA diver hand-pulling or DASH harvesting could be performed in high-use areas of the lake to provide area specific control of nuisance aquatic plants. While both approaches would be effective it is likely that some degree of annual maintenance would be required to maintain desirable plant densities. Annual hand-pulling of DASH harvesting of specific areas of the lake will be fairly expensive; with per acres costs ranging from $10,000-$15,000.

Mechanical Control (not recommended)

Several different approaches are used to mechanically remove aquatic vegetation. The most commonly employed strategies include dredging, harvesting and hydro-raking.

- <u>Dredging</u> - Dredging involves the removal of bottom sediment to add water depth. It controls aquatic vegetation through physical removal of the plant and root structures and nutrient-rich sediments, leaving nutrient-poor sediments less suitable for plant growth. There can also be the added benefit of increasing water depth below the photic zone or the depth that light can penetrate to support plant growth.

  Dredging is not a recommended strategy for aquatic vegetation control at the Forest Lake. Dredging the lake would be very costly and would cause significant disturbance to the lake shoreline while providing limited benefit to the lake. Even a limited dredging project targeting areas of accumulated sediment would be expensive. Typical removal cost range from $20-$40 per cubic yard so even a limited project targeting removal of 1 feet of sediment in over a 5 acre area would produce approximately 8,000yds^3 and would cost $160,000-$320,000 to remove. The additional 1 feet in depth gained from a small scale dredge such as this would do little to discourage rooted plant growth. Permitting and planning a dredging project is also a lengthy and involved process that generally costs upwards of $40,000.

- *Harvesting* - Cutting and collecting aquatic vegetation with specialized equipment is termed mechanical harvesting. Mechanical harvesters are barges propelled by paddle wheels and equipped with depth-adjustable cutting heads and conveyor-mesh storage areas. Plants are typically cut near the sediment and water interface, usually to a maximum depth of 7 feet.

  A harvester could be considered for use at Forest Lake to control nuisance growth of Richardson's pondweed at Forest Lake. Given the typically growth rate for Richardson's Pondweed we would expect that acceptable control could be maintained with one mid summer harvest. Given the size of the area to control (10-15 acres) we expect that one harvest would cost $7,500-$10,000. Disposal of harvested material would be additional, and is generally handled by an outside contractor. It the case of Forest Lake it is possible that the City may assist in removal of harvested spoils. Harvesting would likely need to be performed annually, although over time we would expect pondweed densities to decrease as the seed back is depleted.

- *Hydro-Raking* - Mechanical hydro-raking involves the removal of aquatic plants and their attached root structures. Hydro-rakes are best described as floating backhoes. The barge is powered by paddle wheels similar to a harvester, and it is equipped with a hydraulic arm that is fitted with a York rake attachment. The rake tines dig through the bottom sediments, dislodging the plants in water depths up to approximately 12 ft. Most hydro-rakes do not have on-board storage, so each rake full needs to be deposited directly on-shore or else onto a separate transport barge. Plants with large, well-defined root structures like waterlilies and emergent species are most efficiently removed through hydro-raking. In some cases, control of these and similar species can be attained for 3-4 years or longer. This approach is also sometimes favored for annual weed maintenance of beach and swim areas.

  The use of a hydro-rake is not recommended for Forest Lake. While the hydro-rake could likely be used for removal of nuisance vegetation in some swim areas/private access areas, it is typically reserved for removal of plants with large root systems and removal of organic debris. The native species that are problematic in Forest Lake are seed-bearing annuals so it is likely that removal would have to be performed annually.

Aeration

Artificial aeration is a technique by which the dissolved oxygen levels within a lake or lake are enhanced by introducing atmospheric oxygen into the water column through mechanical means. In addition to augmenting ambient dissolved oxygen levels, most aeration methods promote increased water agitation and circulation through the creation of surface disturbance and internal convection currents.

Increased dissolved oxygen not only provides a more favorable environment for resident warmwater fish and wildlife, but also enables more continuous microbial breakdown of organic material at the sediment/water interface. This more efficient breakdown of organics can help slow the accumulation of soft sediment. Increased water circulation and surface agitation also helps to slow the growth of algae.

Aeration is typically a recommended management option for shallow eutropic lakes, but is not generally advised for larger waterbodies like Forest Lake. A system that could sufficiently augment oxygen concentration in the pond would be very large requiring many diffuser stations as well as having significant associated costs for running and maintenance. Further if an aerator sufficiently sized for the lake was installed the lake would destratify due to the continual mixing causing a disruption the natural stratification process.

Drawdown

Lowering water levels during the winter months to expose aquatic plants to freezing and desiccation (drying) is a commonly used management approach in northern climates. Drawdown is particularly effective on perennial plants such as milfoil, but has little impact on seed producing native plants which germinate from seed each spring. Winter drawdown is already practiced at Forest Lake.

Biological Controls

The introduction of herbivorous insects and fish is often considered to be a natural and potentially long-term management strategy to control excessive aquatic vegetation. Sterile or triploid grass carp (C*tenopharyngidon idella*) that consume aquatic plants are regularly used as a management strategy in southern tier states. In the Northeast, they can only be used in New York and Connecticut waterbodies under site specific permits and provided that certain conditions are met. While grass carp may help suppress some of the aquatic plant growth in the Forest Lake stocking of triploid grass carp is not currently permitted in Massachusetts. Currently no insects have shown potential for control of the nuisance species in Forest Lake.

Phosphorus Inactivation

Abundant phosphorus or nuisance algae are not currently problematic at Forest Lake,. If nutrient reduction were need in the future the use of Aluminum Sulfate (Alum) should be considered to bind and strip available phosphorus.

Herbicide Treatment

The use of USEPA/MA DAR registered herbicides to control nuisance aquatic plant and algae growth is probably the most widely used management strategy for lakes with aquatic plant infestations that are beyond effective control with non-chemical techniques like hand-pulling, suction harvesting or bottom barriers. Herbicides that are registered for aquatic use must meet strict federal guidelines and demonstrate that there is not an "unreasonable risk" to human health and the environment when applied in accordance with their product label. According to Madsen (Madsen 2000), "currently no product can be labeled for aquatic use if it poses more than a one in a million chance of causing significant damage to human health, the environment, or wildlife resources. In addition, it may not show evidence of biomagnification, bioavailability or persistence in the environment".

Performing chemical treatments in lakes and lakes is a highly regulated activity. Aquatic herbicides and algaecides are subject to periodic re-registration with the U.S. Environmental Protection Agency (EPA) where the latest technology and scientific studies are used to evaluate the potential impacts of these products. Most of the commonly used products have recently completed EPA's more stringent re-registration process. Aquatic herbicides and algaecides must also be registered for use in Massachusetts. Aquatic treatments in Massachusetts must obtain a site-specific License to Apply Chemicals from the Department of Environmental Protection, Division of Watershed Management and must be approved by the local Conservation Commission(s). Applications must be performed under the direct supervision of an Aquatic Applicator that is Commercially Certified and licensed in Massachusetts.

Herbicide treatment is not recommended for control of the nuisance species in Forest Lake. While herbicides could be used to effectively control the vegetation in the lake, lake-wide control is not necessary or warranted given the species composition or the usage patterns of the lake. Use of aquatic herbicides should be reserved for situations where other control methods cannot provide effective control or no reasonable alternative exists. In the case of Forest Lake the current vegetation distribution and native composition provides desirable fish and wildlife habitat while having little detrimental impacts on recreational use of the lake.

In the event of an introduction or establishment of a non-native, invasive aquatic plant the use of herbicides should be considered to curb and control spread where possible.

MANAGEMENT RECOMMENDATIONS

Deciding what management technique or combination of management techniques to use for nuisance aquatic plant control in a given lake system can be a difficult decision to make and is dependant on number of factors including lake morphology, size of area to be managed, plant species present, management objectives, cost and regulatory restrictions. Formulating realistic and attainable management objectives is a critical first step when developing an integrated, long-term management program.

Overall it appears that Forest Lake is in relatively good shape with regards to plant distribution, species present and water quality. All of the plants identified in the lake are native plants that are typically non-invasive or problem forming; more importantly no non-native, invasive plant species were identified in the lake. Tested water quality parameters were also quite favorable and did not indicate any acute issues; although more comprehensive testing would have to be preformed to establish credible baseline values for the lake

Given the current conditions in the lake we are recommending a management program focused on area specific control of dense nuisance aquatic plant growth in high-use, private access and swim areas to maintain safe recreational access to the lake, however, given the overall distribution and composition of aquatic plant species in the lake at the current time lake-wide management of aquatic plants is not advisable. We feel that these goals can be best achieved using benthic barriers and SCUBA diver hand-pulling.

Continued monitoring of the lake is critical and should be performed annually so that appropriate actions can be taken if an unwanted species is identified in the lake. Given the presence of a public boat ramp it is likely that at some point in time an unwanted species (i.e. milfoil) will enter the lake and early identification and management will be paramount to its successful management.

Forest Lake - Methuen, MA

Photographs taken on: 7/30/12

Representative plant cover: thinleaf pondweed (*P. Pusillus*), Naiad (*Najas sp*), waterweed (*Elodea canadensis)* & Richardson's Pondweed (*P. richarsonii)*

Tapegrass (*Vallisneria americana*) with flower stalks reaching towards the water's surface

White waterlilies (*Nymphaea odorata*) along shore

Shoreline growth of cattails (*Typha sp.)*

Forest Lake

Methuen, MA

Vegetation Distribution - Sept. 12'

FIGURE:	SURVEY DATE:	MAP DATE:
1	9/10/12	12/12/12

Legend:

N

- Low density, scattered Richardson's pondweed, thinleaf pondweed and tapegrass (Density Index:1; Biomass: 1)
- Low-moderate density Richardson's pondweed, thinleaf pondweed and tapegrass. Greater cover of waterweed and spikerush in the southern half of the lake. (Density Index:1-2; Biomass 1-2)
- Dense Richardson's pondweed (Density Index:3-4; Biomass 3-4)
- Dense cover of thinleaf pondweed (Density Index: 4; Biomass: 3-4)
- Waterlilies

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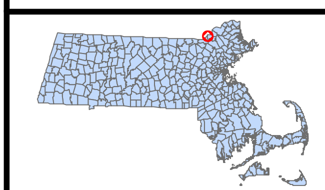
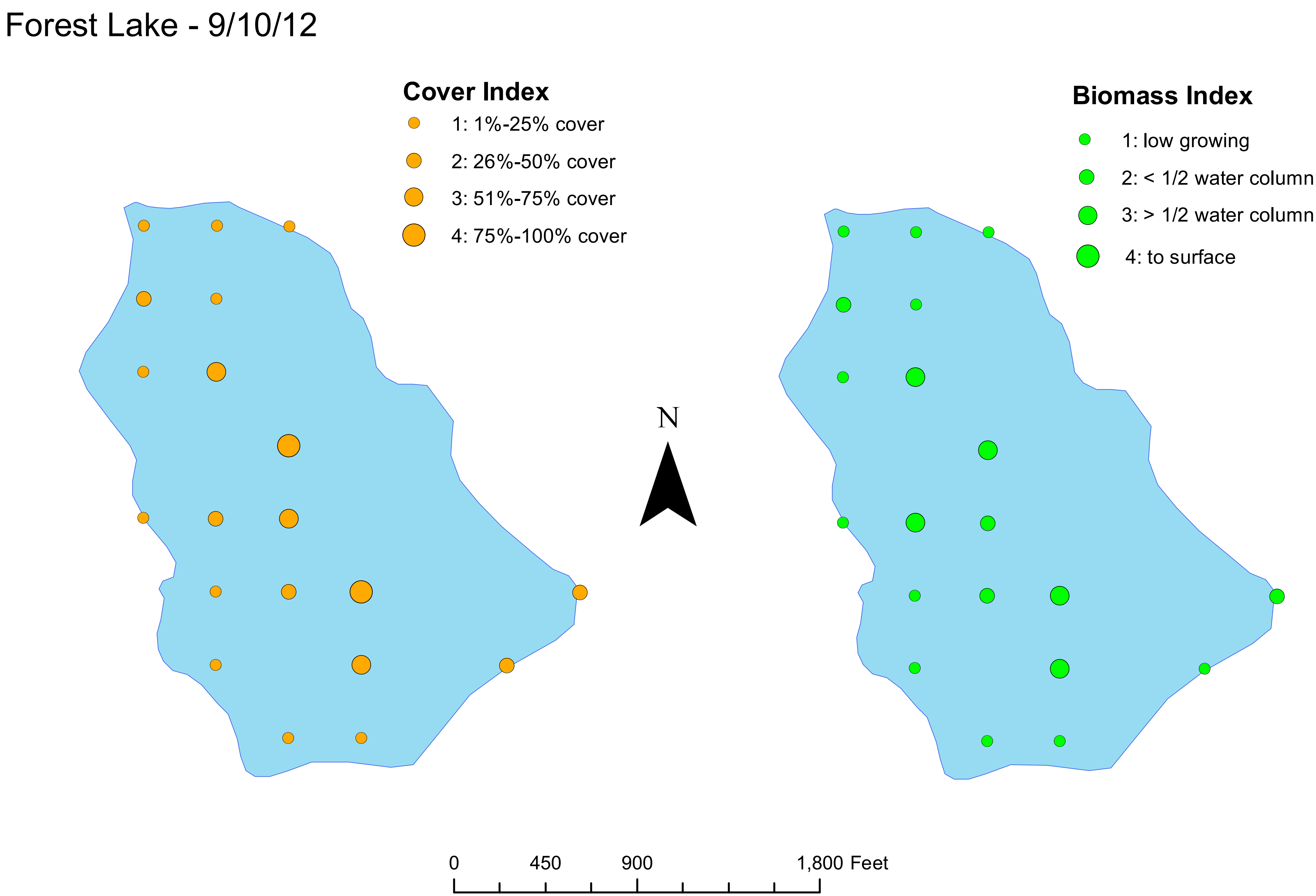
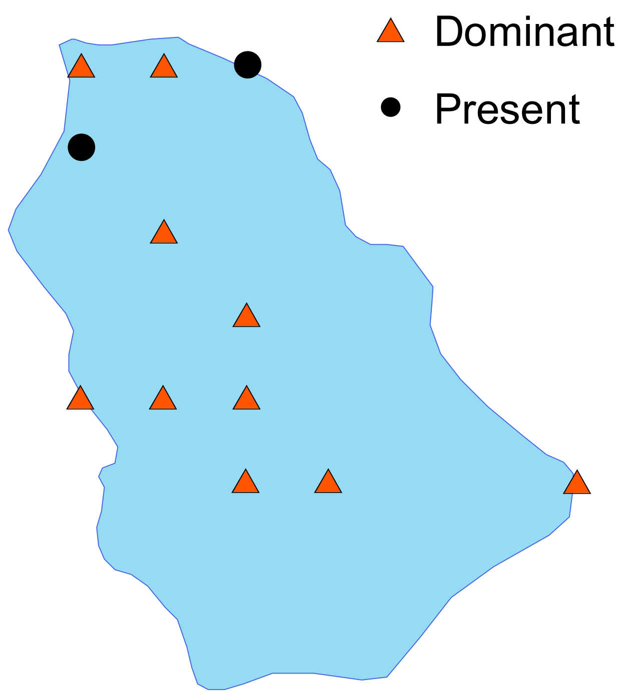
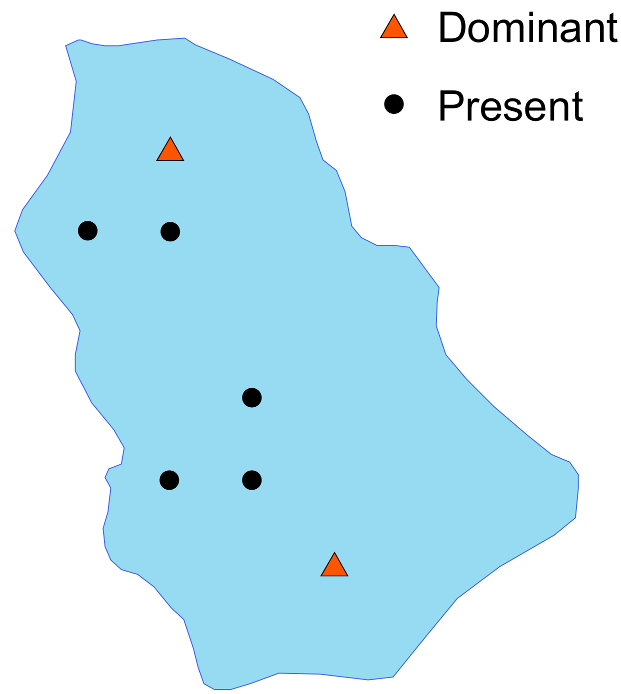



Forest Lake - 9/10/12
Cover Index
1: 1%-25% cover
2: 26%-50% cover
3: 51%-75% cover
4: 75%-100% cover
Biomass Index
1: low growing
2: < 1/2 water column
3: > 1/2 water column
4: to surface
N
0
450
900
1,800 Feet

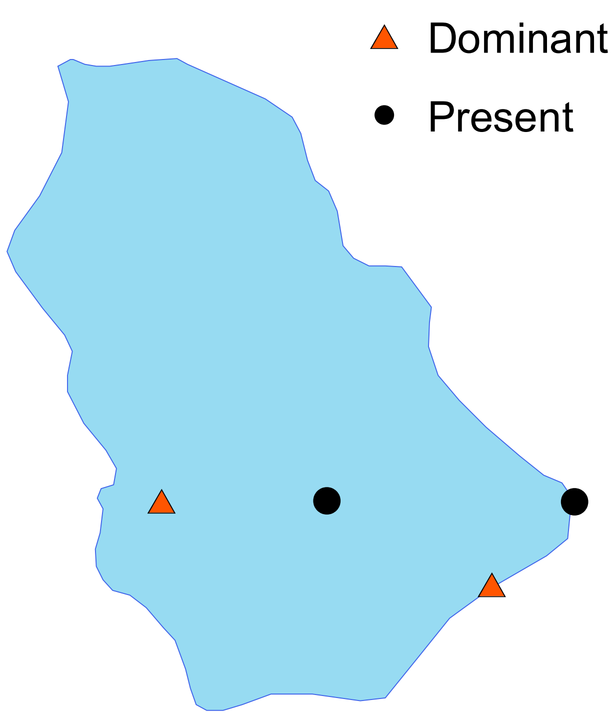
Distribution of *Potamogeton richarsonii*



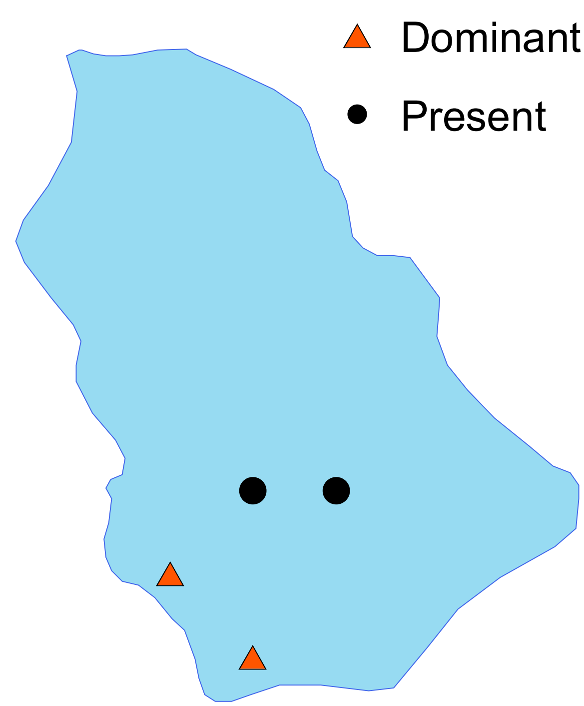
Distribution of *Potamogeton pusillus*



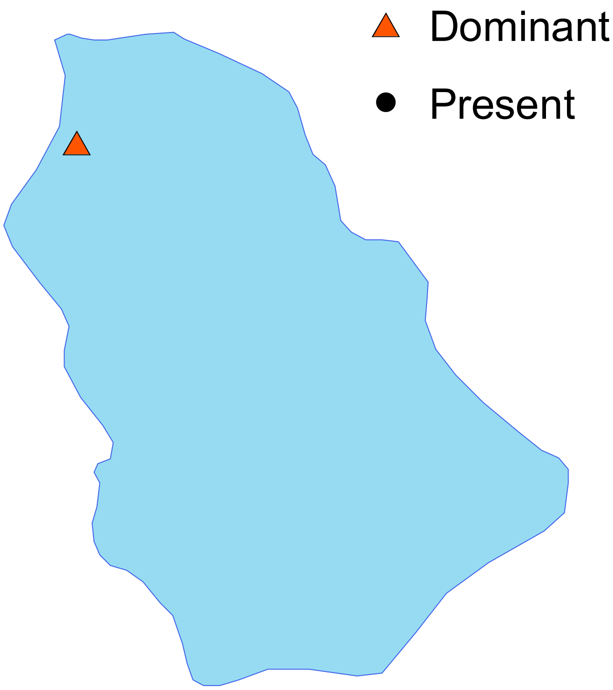
Distribution of *Elodea canadensis*



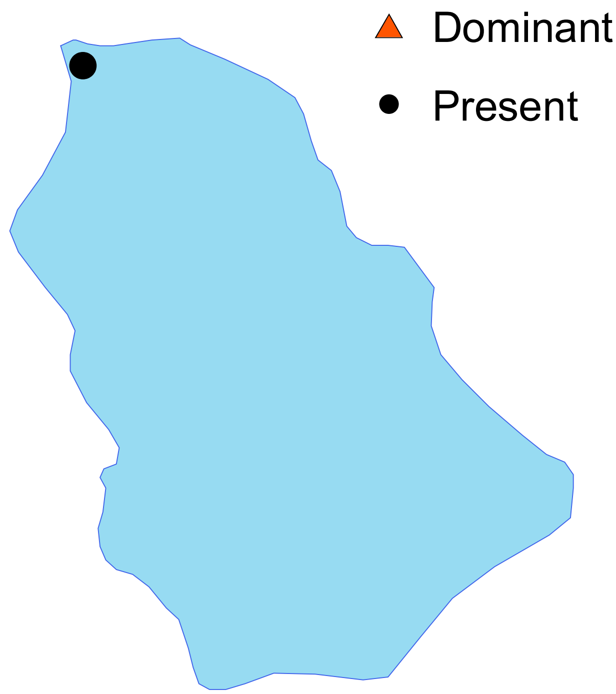
Distribution of *Eleocharis tenuis*



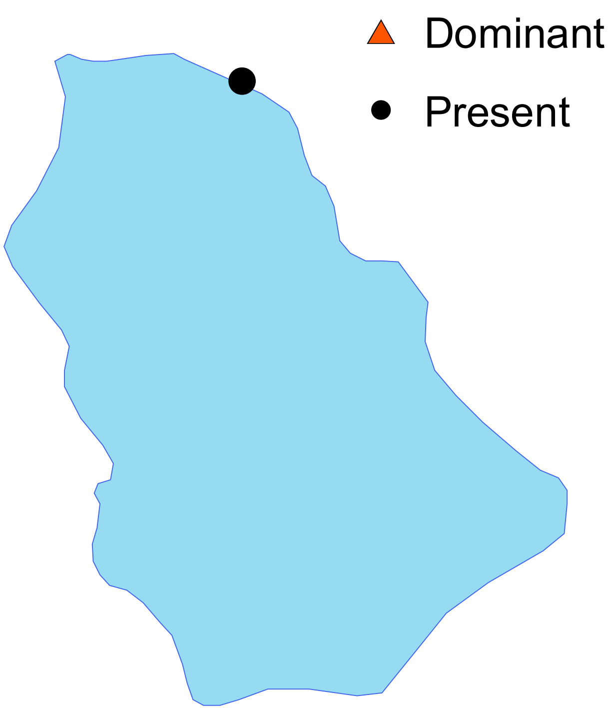
Distribution of *Vallisneria americana*



Distribution of *Potamogeton robbinsii*



Distribution of *Nymphaea odorata*



Distribution of Filamentous algae